

Serum LH, FSH and Prolactin Levels During the Estrous Cycle in the Hamster (37853)

P. VARAVUDHI¹ AND J. MEITES²

Department of Physiology, Michigan State University, East Lansing, Michigan 48824

Studies in the female rat during the estrous cycle have shown that serum LH, FSH and prolactin (PRL) reach peak levels on the late afternoon of the day of proestrus (1, 2). Thereafter there is a rapid fall in serum LH to basal levels, whereas FSH and PRL decline more gradually. The surge in LH (and FSH) on the afternoon of proestrus is believed to be responsible for the subsequent ovulation on the early morning of estrus, whereas the rise in prolactin is believed to induce luteolysis of the old corpora lutea (3). To the authors knowledge, no reports have yet appeared on changes in serum PRL and FSH during the estrous cycle of the hamster, but LH has been observed to rise to peak values on the afternoon of proestrus (4-6). It was the purpose of this investigation to measure these 3 hormones in the serum during each day of the estrous cycle in the hamster.

Materials and Methods. Mature female golden hamsters (Lakeview Hamster Co., New Field, NJ) 3 to 3.5 mo old and weighing 120-135 g each, were used in this study. They were housed in a temperature ($75 \pm 1^\circ\text{F}$) and light controlled (14 hr light daily) room, and were fed Wayne Lab Blox pellets (Allied Mills, Chicago, IL)

¹ Exchange of Research Workers Grantee, World Health Organization, during course of this investigation. Present address: Chulalongkorn University, Faculty of Science, Bangkok, Thailand.

² Aided in part by NIH research grants AM 04784 from The National Institute of Arthritis and Metabolic Diseases, and CA 10771 from The National Cancer Institute. Please address reprint requests to J. Meites. Published with the approval of the Michigan Agricultural Experiment Station as Journal Article No. 6548.

and tap water ad lib. Only hamsters exhibiting at least 2 consecutive 4-day cycles, as indicated by the presence in vaginal smears of a postestrous discharge every 4 days, were used. The postestrous discharge is characteristically thick, white, opaque, viscous and homogenous in appearance (7). The day of proestrus was considered to be the day prior to the day of postestrous discharge, estrus as the day of postestrous discharge, metestrus as the day after the day of postestrous discharge, and diestrus as the day between metestrus and proestrus.

Twenty one hamsters were divided into 4 subgroups of 5 to 6 animals each, and 0.6 to 0.8 ml of blood was removed by cardiac puncture under light ether anesthesia from representative animals in each subgroup at 9 AM daily, with the exception of the day of proestrus when blood also was collected at 6 PM. The blood was pooled from 3 to 4 animals at each stage of the cycle, with a total of 4 pools/stage of cycle. By this method, sufficient blood was collected so that assays could be done for all 3 hormones at each stage of the cycle. The serum was separated by centrifugation and stored at -20° until ready for assay. Each of the 4 serum pools from each stage of the cycle was assayed in duplicate or triplicate for each hormone.

Prolactin (8), LH (9) and FSH (10) were measured by double antibody radioimmunoassays (RIA). The rat reference preparations used were rat-prolactin-RP-1, rat-LH-RP-1 and rat-FSH-RP-1.³ Rat and

³ Acknowledgment is made to the Hormone Distribution Officer, NIAMD, NIH, Bethesda, MD, for the RIA preparations.

hamster prolactin have been shown to cross react with rat prolactin antibody and to produce parallel curves (11), although the rat system has not been completely validated for the hamster. The heterologous ovine radioimmunoassay for LH developed by Niswender *et al.* (12) has been used and validated for measuring serum LH in hamsters (4–6). It does not cross react with FSH. The rat FSH radioimmunoassay system (10) has not yet been used previously in the hamster. Significance of differences between any 2 groups was analyzed by Student's *t* test.

Results. Serum prolactin rose at 6 PM on the day of proestrus, and remained relatively constant during diestrus, estrus and metestrus (Table I). Serum LH showed a marked rise on the afternoon of proestrous day, reaching 279.8 ng/ml compared to 17.7–23.9 ng/ml on all other stages of the cycle. Serum FSH also rose sharply on the afternoon of proestrus and remained as high on the morning of estrus. The serum FSH values on the morning of estrus were not statistically different from the values on proestrous afternoon. Serum FSH fell on the morning of metestrus but was still higher than on the mornings of diestrus or proestrus.

Discussion. The present study indicates that serum PRL, LH and FSH in the cycling female hamster follow trends basically similar to those in the cycling female rat, with highest values for all 3 hormones reached on the afternoon of proestrous day. However, there are some differences

indicated here between the hamster and rat. Thus serum concentrations of PRL during the estrous cycle are higher in the rat, with basal levels of 20–40 ng/ml on each morning of the cycle and a peak rise of up to 300 ng/ml or more on the afternoon of proestrus (1, 2, 8). It is possible that the rat RIA for prolactin does not measure all the prolactin in the serum of hamsters. The possible function of the rise in PRL on the afternoon of proestrous day in the hamster is unknown, although it may contribute to the marked rise observed in progesterone secretion at this time in the hamster (6). Apparently the rise in PRL is not responsible for luteolysis of the old corpora lutea, as in the rat (3), since the old corpora lutea in the hamster disappear prior to the day of proestrus and do not require the presence of the pituitary (13).

The concentrations of serum LH during each morning of the cycle in the hamster observed in the present study are in agreement with those reported by other workers (4–6). Goldman and Porter (4) observed peak serum LH values of 90–200 ng/ml between 3–4 PM on the day of proestrus, whereas Blake, Norman and Sawyer (5) noted average serum levels of 1005 ± 143 ng/ml between 2:30–3:30 PM on the day of proestrus and Labhsetwar, Joshi and Watson (6) found average serum LH concentrations of 697.15 ± 124.43 ng/ml between 2:01–10:30 PM on proestrous day. Since we measured serum LH only at 6:00 PM on the afternoon of proestrus, it is possible that we missed the peak serum

TABLE I. Serum Prolactin, LH and FSH During the Estrous Cycle of 21 Hamsters.^a

Stage of cycle	Prolactin (ng/ml)	LH (ng/ml)	FSH (ng/ml)	
Diestrus, 9:00 AM	8.8 ± 0.8 ^b	22.2 ± 5.5	7.8 ± 2.4	
Proestrus, 9:00 AM	3.2 ± 0.1	17.7 ± 2.8	5.8 ± 1.0	
Proestrus, 6:00 PM	24.4 ± 5.9 ^c	279.8 ± 29.5 ^c	137.7 ± 14.7 ^c	} NS ^d
Estrus, 9:00 AM	7.0 ± 0.6	22.2 ± 5.5	205.0 ± 32.2 ^c	
Metestrus, 9:00 AM	8.4 ± 1.4	23.9 ± 3.4	41.8 ± 5.3 ^c	SD

^a Four serum pools were measured per stage of cycle.

^b Mean and standard error of mean.

^c Significantly higher than values at other stages of cycle ($P < 0.01$).

^d NS = not significantly different ($P > 0.05$); SD = significantly different ($P < 0.01$).

LH values on that day.

The pattern of serum FSH concentrations observed in the hamster appears to parallel progesterone secretion as reported by Labhsetwar, Joshi and Watson (6) in the cycling hamster. Significantly increased progesterone secretion was found on the afternoon of proestrus and it persisted on the morning and afternoon of estrus and on the morning of metestrus. In the present study, the marked rise in serum FSH on proestrus afternoon persisted until the morning of estrus, and serum FSH at metestrus was still higher than on diestrus and proestrous morning. Greenwald (14) attributed a luteotropic role to FSH, although the progesterone rise after the critical period on proestrous day also may be due in part to LH release. Confirmation of the present assays of FSH in the serum of hamsters must await validation of the rat RIA for FSH in the hamster.

Summary. Serum LH, FSH and prolactin was measured by radioimmunoassays in 21 mature female golden hamsters at 9 AM on each morning of the 4-day estrous cycle and also at 6 PM on the day of proestrus. All 3 hormones showed peak values at 6 PM on proestrous day, and by the following morning (estrus) LH and prolactin had returned to basal levels. Serum FSH remained as high on the morning of estrus as on the afternoon of proestrus, and although it fell on the morning of metestrus it was still higher than on the mornings of diestrus and proestrus. The persistence of high FSH release on the mornings of estrus and metestrus may be related to the luteotropic function ascribed to FSH in the ham-

ster. The peak rise in all 3 hormones on the afternoon of proestrus in the hamster is similar to that observed for these 3 hormones in the serum of cycling female rats.

1. Gay, V. L., Midgley, A. R., Jr., and Niswender, G. D., *Fed. Proc., Fed. Amer. Soc. Exp. Biol.* **29**, 1880 (1970).
2. Meites, J., Lu, K. H., Wuttke, W., Welsch, C. W., Nagasawa, H., and Quadri, S. K., in "Recent Progress in Hormone Research" (G. Pincus, ed.). Vol. 28, p. 471. Academic Press, New York, (1972).
3. Wuttke, W., and Meites, J., *Proc. Soc. Exp. Biol. Med.* **137**, 988 (1971).
4. Goldman, B. D., and Porter, J. C., *Endocrinology* **87**, 676 (1970).
5. Blake, C. A., Norman, R. L., and Sawyer, C. H., *Biol. Reprod.* **8**, 299 (1973).
6. Labhsetwar, A. P., Joshi, H. S., and Watson, D., *Biol. Reprod.* **8**, 321 (1973).
7. Orsini, M. W., *Proc. Anim. Care Panel* **11**, 193 (1961).
8. Niswender, G. D., Chen, C. L., Midgley, A. R., Jr., Meites, J., and Ellis, S., *Proc. Soc. Exp. Biol. Med.* **130**, 793 (1969).
9. Monroe, S. E., Rebar, R. W., Gay, V. L., and Midgley, A. R., Jr., *Endocrinology* **85**, 720 (1969).
10. Parlow, A. F., Daane, T. A., and Schally, A. V., *Proc. 51st Meet., Endocrine Soc.* p. 83 (1969).
11. Chen, C. L., PhD thesis, Michigan State Univ., 1969.
12. Niswender, G. D., Midgley, A. R., Jr., Monroe, S. E., and Reichert, L. E., Jr., *Proc. Soc. Exp. Biol. Med.* **128**, 807 (1968).
13. Hilliard, J., *Biol. Reprod.* **8**, 203 (1973).
14. Greenwald, G. S., *Endocrinology* **8**, 118 (1967).

Received Sept. 6, 1973. P.S.E.B.M., 1974, Vol. 145.